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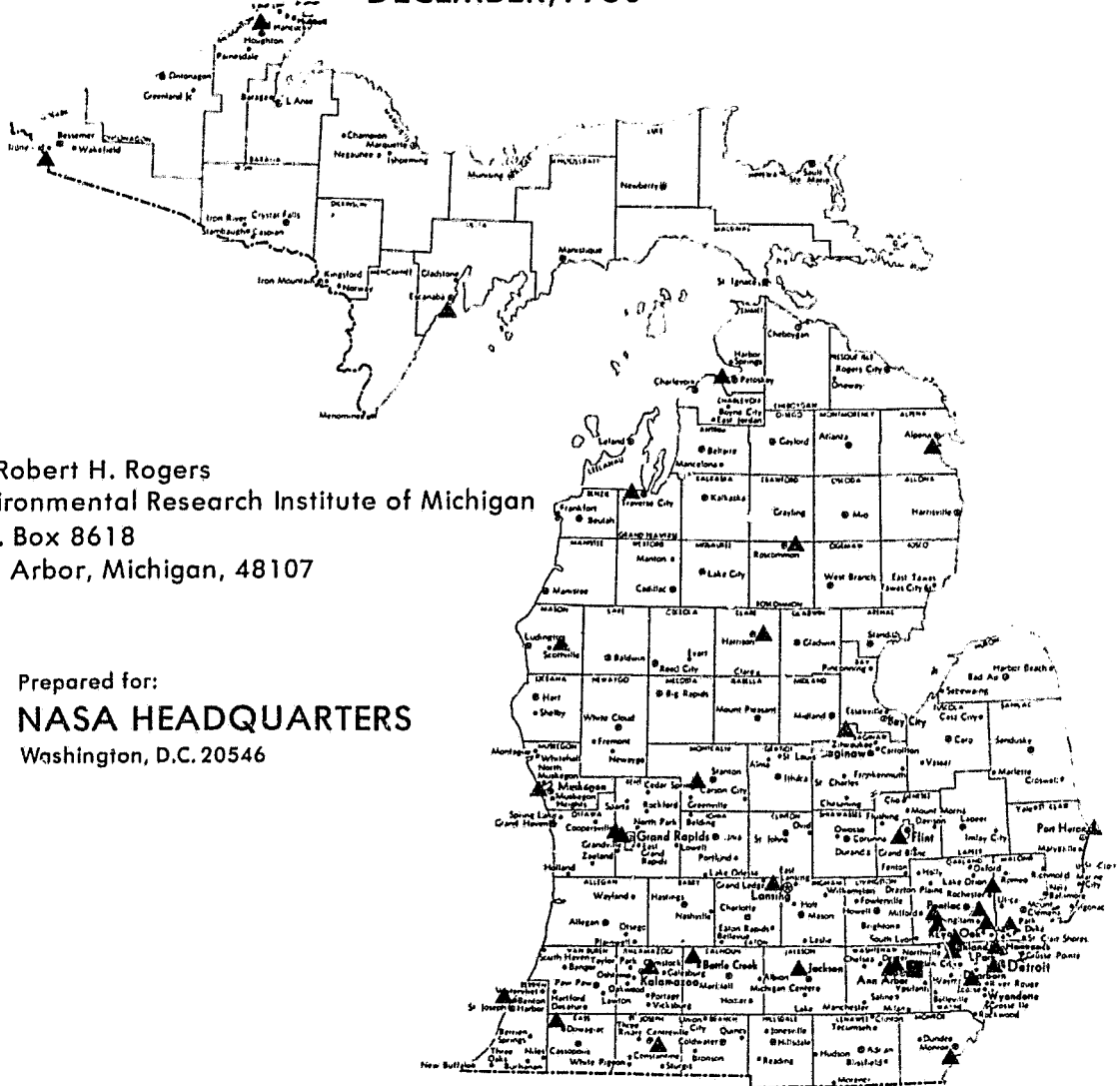
ERIM No. 147200-13-F



## Final Report

# LANDSAT TECHNOLOGY TRANSFER TO THE PRIVATE AND PUBLIC SECTORS THROUGH COMMUNITY COLLEGES AND OTHER LOCALLY AVAILABLE INSTITUTIONS

DECEMBER, 1980



■ Environmental Research Institute of Michigan  
Ann Arbor

▲ LOCATIONS OF COMMUNITY, JUNIOR, AND TECHNICAL COLLEGES WITHIN THE  
STATE OF MICHIGAN

(E82-10181) LANDSAT TECHNOLOGY TRANSFER TO  
THE PRIVATE AND PUBLIC SECTORS THROUGH  
COMMUNITY COLLEGES AND OTHER LOCALLY  
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16. Abstract  NASA established a 12-month program with the Environmental Research Institute of Michigan (ERIM) on 20 December 1979 with the objective of investigating methods of making Landsat technology readily available to a broader set of private sector firms through local community colleges. This report summarizes the major first-year accomplishments of this very successful technology transfer effort and provides the plans for the next 12-month period. To achieve the desired objective, i.e., the transfer of Landsat technology - the program applies a network where the major participants are NASA, university or research institutes, community colleges, and local private and public organizations. The methodology employed by the program gives local users an opportunity to obtain "hands-on" training in Landsat data analysis techniques, using a desk-top, interactive "Remote Analysis Station" (RAS). The RAS communicates with a central computing facility via telephone line, and provides for generation of land cover maps and data products via remote command.					
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## Preface

We at ERIM are very pleased with the initial success of the Landsat Technology Transfer through Community College programs. The degree of success can be measured by the enthusiastic response of most of the program participants, the efforts currently being made by a number of organizations to obtain their own Landsat capability patterned after what was used in this program, and the additional organizations that wish to participate in the future.

In a large part, the success of the program can be ascribed to the dedication and enthusiasm of the many people and organizations outside of ERIM that were involved in the program. Particular thanks should be given to Dr. Eugene Jaworski and his staff at Eastern Michigan University. Dr. Jaworski was largely responsible for the RAS User's Manual and much of the training material. Further, the EMU facility was used as a test bed and training ground during the initial workshops. Other facilities participating as hosts were Daedalus Enterprises (Steve Goodman), C.S. Mott Community College (Dr. Douglas E. Laine), Michigan GLS Region (Robert Karwowski), Wayne County Community College (Dr. Elaine J. Wallace), Southeast Michigan Council of Governments (Danial Snyder), and the Detroit Edison Company (Mr. William T. Cummings). We wish to gratefully acknowledge the hard work and support provided by these people and their organizations, without which the success of the program could not have been achieved.

We also wish to acknowledge the vision and support of the NASA personnel who recognized the potential of the project and saw to it that the program got off to a good start. Specifically, we would like to thank Mr. Floyd Roberson of NASA Headquarters, who was convinced that the network of community colleges of the Southeastern Michigan Technical Assistance Program (SEMTAP) could be used for Landsat technology transfer, and Messrs. J. Weber\* and T. Austin\*\* of NASA Goddard Spaceflight Center, who so ably assisted in getting the program started.

\*Now with NASA Hqs.

\*\*Now with OAO

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## BACKGROUND

Since the initiation of the Landsat program, most government technology transfer efforts dealing with Landsat use have been focused primarily on the public sector - Federal agencies and State governments - and have not involved the private sector to any significant extent. The application of Landsat data in the private sector has been limited primarily to the private suppliers of Landsat data processing and analysis equipment and services - aerospace companies and a limited number of users in sectors such as the mineral and petroleum industry and timber companies. However, there are many other potential private users who have not yet incorporated Landsat technology in their array of services; some examples are architectural and engineering firms, computer data processing firms, energy and environmental companies, and other consultants providing services in land use planning and development. Lack of greater involvement by these potential users has retarded the growth of Landsat technology, since engineering firms do much of the land use mapping for both government and private industry.

Recent surveys show that a large number of potential users in the private sector and at local agencies are interested in becoming consumers or suppliers of Landsat-derived products and services. However, they have been prevented from entering this market by the high cost of analysis facilities and the difficulty of obtaining training in the new technology. To evaluate methods for bridging this gap NASA established a 12-month program with the Environmental Research Institute of Michigan beginning 20 December 1979 with the objective of investigating methods of making Landsat technology readily available to a broader set of private sector firms through local community colleges.



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TECHNICAL APPROACH

To achieve the desired objective - the successful transfer of Landsat technology - the program applies a network (Figure 1) where the basic partners are NASA, a university or research institute, community colleges, and local-private and public organizations. The methodology employed by the program gives local users an opportunity to obtain "hands-on" training in Landsat data analysis techniques, using a desk-top, interactive "Remote Analysis Station" (RAS). The RAS communicates with a central computing facility via telephone line, and provides for generation of land cover maps and data products via remote command.

The role of the university or research institute in this model network, is to provide demonstration and training host computer services for the Remote Analysis Station (RAS), develop training packages and programs, and to support seminars, minicourses and workshops staged by the community colleges. For their part, the colleges classify and organize business and industry in their neighborhoods in accordance with technical or information needs, organize and host seminars for potential users and suppliers of Landsat data products, and serve as local contact points for technical assistance.

To meet the needs for the use of RAS terminals for both training and demonstration projects an agreement was established in Phase I where local organizations, selected for demonstration projects, would also support college-sponsored seminars by providing off-campus sites for the terminals as well as staff to help the trainees. These hosts would in turn have an opportunity to use the terminals on a time-

available basis to conduct the demonstration projects and to train other employees of their organization.

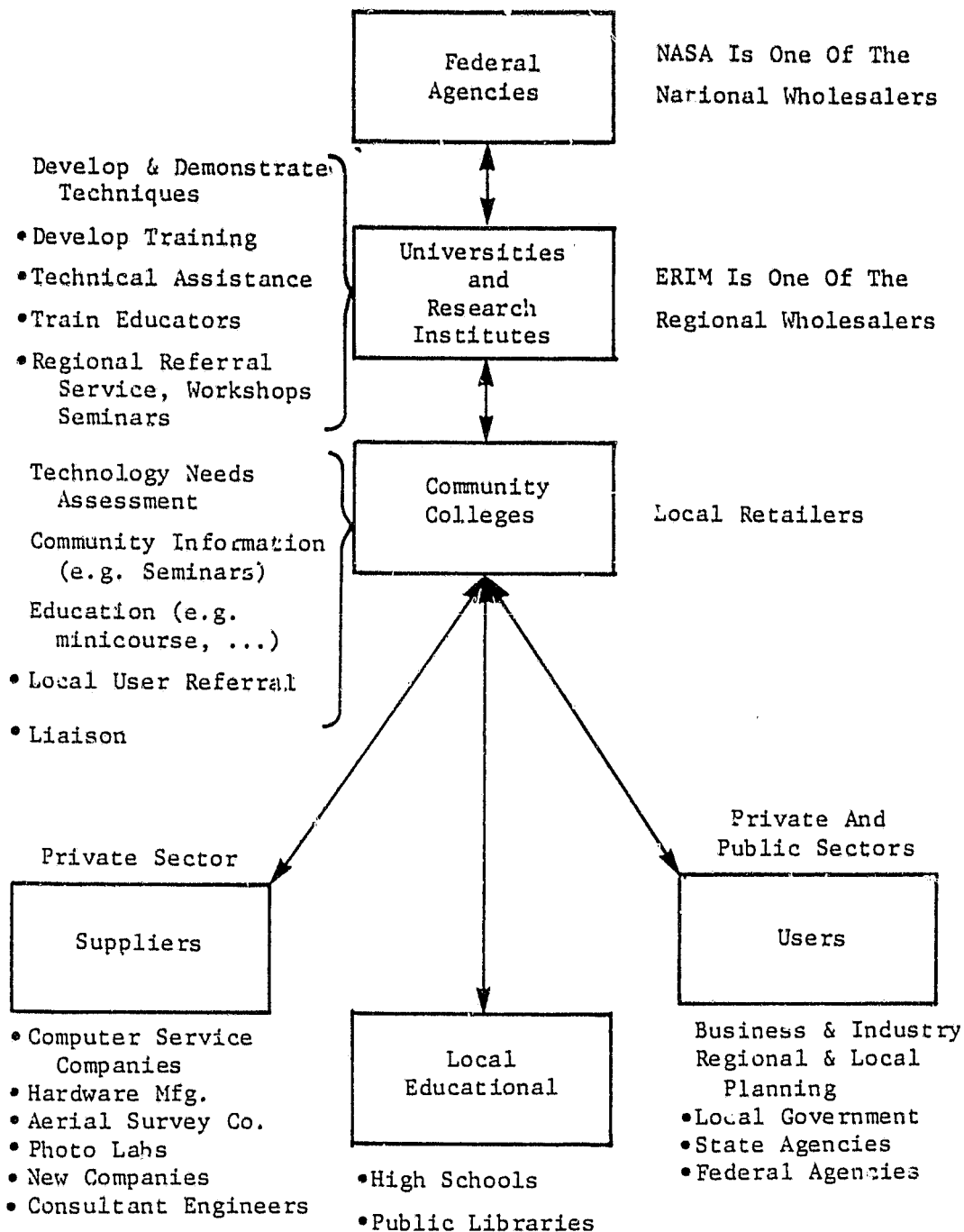
This basic agreement used during Phase I to link the academic institutions with private and public organizations participating as hosts for a RAS terminal follows:

1. The host organization must have one or more persons trained in the use of the terminal before it is moved on-site.
2. If the RAS terminal is made available to the public (e.g., registered trainees from outside the host organization), one or more persons at the host facility will be identified as an associate instructor to help trainees as needed. The associate instructor will not generally receive payment from the college or from NASA for this support.
3. In lieu of payment for supporting the training of registered participants, the associate instructor may use the RAS terminal on a time-available basis to conduct a demonstration project and to train other employees of the host organization. The staff being trained at the host facility would not normally pay college fees unless college credits are needed.

This agreement for sharing program resources (i.e., two terminals) and the model network of Figure 1 were successfully applied in southeast Michigan during Phase I to deliver Landsat technology to 100 or more practicing professionals at the "grass roots" level. A summary of this activity follows in Section 3 together with the recommendations and plans for a Phase II effort (Section 3.4) which continues the expansion of the use of Landsat technology involving additional community colleges and more local users.



Figure 1. FUTURE NETWORK TO EXTEND LANDSAT  
TECHNOLOGY TO THE PRIVATE SECTOR



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SUMMARY PHASE I PROGRAM

To achieve the desired objective - the successful transfer of Landsat technology - the first 12-month program accomplished the following specific objectives:

1. Established program participants (e.g., colleges, engineering firms, etc.) for three cooperative transfer efforts which demonstrated an effective method of transferring Landsat technology to the private sector and local agencies at the "grass roots" level.
2. Developed an operating methodology for the remote, interactive analysis of Landsat data and the generation of the output product.
3. Developed and implemented technology transfer and training at "grass roots" level.
4. Developed a plan for expanding the technology transfer program, on a self-sustaining pay-as-you-go basis for users, with seed money for community college training grants.

To facilitate comparisons between the work accomplished and these four objectives, this section is organized into four subsections having the same titles as the program objectives.

3.1 ESTABLISH NETWORK PARTICIPANTS

This objective required the development of plans and selection of initial participants for a network (Figure 1) to effectively transfer Landsat technology to the private sector and local agencies (grass roots). Program constraints (e.g., funding and facilities) limited the participants to:

- o Three colleges to organize and conduct the seminars.
- o Four local organizations from the private and public sector to provide host facilities for the terminals for training and demonstrations.
- o Three principal instructors and seven assistant instructors to deliver the training.
- o About 80 trainees.

Activity to identify these participants included three workshops (Figure 2) and user awareness publications followed up with questionnaires to establish: user interest and possible applications for Landsat technology; and user preferences regarding training methods, locations for classes, etc. Criteria used to select participants included: expressed interest in remote sensing and Landsat technology; and, in the case of the private and public sector users, available application and market for use of Landsat products. Another important criterion was the willingness and likelihood that the participant would continue to use or provide training in the use of Landsat technology.

The workshops and discussions with NASA established the colleges and local organizations who would participate in the initial training and demonstration programs. To reach as many practicing professionals as possible within southeast Michigan the participants were organized by region into three cooperative efforts for the purpose of delivering the training and demonstrations. Participants in all three transfer efforts included the Southeastern Michigan Technical Assistance Program (SEMTAP) and the Michigan Community College Association (MCCA). SEMTAP and MCCA are coordinating the results of this investigation with other community colleges in the state and assisting with Phase II planning.

The Phase I network participants and their roles in the transfer activity, as described in the following, demonstrate one method by



Figure 2. Reviewing Landsat Technology Transfer Program  
With Community College Presidents And Staff



Flint, Michigan, 48503 (313) 762-0278. A three-day seminar at this college was followed by hands-on training on the RAS terminal at Mott Community College and the Genessee-Lapeer-Shiawassee (GLS) Regional V Planning and Development Commission (PDC) Office. Eight trainees registered for this program.

The principal instructor for this seminar was Robert Karwowski, who represented both Mott Community College and the GLS Region V Office. Associate Instructors included John Coil of GLS Region V and Phillip E. Chase of Johnson and Anderson, a major consulting engineering organization in Pontiac, Michigan. A radio-TV media event was staged on October 19, 1980, in Flint, Michigan, to increase public awareness about Landsat technology transfer efforts.

This second cooperative effort and the third (reviewed in the next section) included non-profit regional planning agencies (i.e., GLS Region V and SEMCOG) as partners with the community colleges. This relationship facilitates marketing Landsat technology over a broader region. These planning organizations have day-to-day working contracts with targeted firms (e.g., consulting engineering organizations) and an already developed assessment of numerous community and business needs which the targeted firms service. In Michigan each county is also within a regional organization boundary providing a network which also links the region to the counties and townships. Regional organizations act as a clearinghouse for environmental, energy, transportation, housing, and economic development programs. Further, since these organizations serve clearinghouse roles, an extensive data base has been developed and serves as a repository for public and private use. Most regional organizations, for example, maintain aerial photographs, various maps (e.g., land use, topographic, soils) and other resource information on their region. This data base must be used, if applicable, by private concerns if federal funds are being requested for work in the region.

which public and private organizations can join in cooperative ventures to transfer Landsat technology at the grass roots level.

#### 3.1.1 FIRST COOPERATIVE TECHNOLOGY TRANSFER:

22 SEPTEMBER TO 4 OCTOBER 1980

This activity consisted of a two-week seminar offered as credit or non-credit by Eastern Michigan University (EMU), and other training and demonstrations supported by the staff of Daedalus Enterprises and EMU students and faculty. Copies of brochures used by EMU and the other colleges to announce the seminars are included in Appendix A.

Since Dr. Eugene Jaworski of EMU prepared the original manuscript of the training package (i.e., workbooks and RAS User's Manual), he was selected to take the lead as the principal instructor for the first seminar. Fifteen trainees registered at EMU for this course. Another key participant in this seminar was Steve Goodman, of Daedalus Enterprises. Mr. Goodman was the associate instructor. A RAS terminal was on-site both at Daedalus in Ann Arbor and at EMU in Ypsilanti, Michigan, so that trainees registering for the seminar could obtain hands-on training at the most convenient location.

The RAS terminal was also used by Steve Goodman while it was on-site at his company to train 12 employees in the analysis of Landsat and aircraft scanner data and to carry out demonstrations of interest to Daedalus. Daedalus is well known as a manufacturer of aircraft scanners and used this program as an opportunity to evaluate Landsat technology and to assess its own role as a potential supplier for Landsat products and services.

#### 3.1.2 SECOND COOPERATIVE TECHNOLOGY TRANSFER;

15 OCTOBER TO 20 NOVEMBER 1980

This technology transfer activity was organized and sponsored by Dr. Douglas E. Laine, of C.S. Mott Community College, 1401 East Court,

This available data base can also greatly enhance the usefulness of Landsat data. Therefore, the regional planning office not only provides a well equipped office for supporting off-campus training, but it also has a well established network which can help the dissemination of Landsat technology.

When the RAS terminal was not in use by trainees registered in the seminar, Bob Karwowski of GLS V office used the terminal to train other members of the GLS V Planning Staff.

### 3.1.3 THIRD COOPERATIVE TECHNOLOGY TRANSFER:

24 OCTOBER TO 19 DECEMBER 1980

This technology transfer effort was composed of a non-credit seminar offered by Wayne County Community College and other coordinated demonstration and training activities involving students and faculty of the community college, the staff of the Southeast Michigan Council of Governments (SEMCOG), and the staff of the Detroit Edison Company. The seminars, designed to reach practicing professionals in the Detroit Metropolitan area, were organized by Dr. Elaine Wallace, Director of Coastal Environmental Studies Project, Wayne County Community College, 8551 Greenfield, Detroit, Michigan, 38228 (313) 584-9381. Dr. Wallace was also the principal instructor for the seminar. Associate instructors include: Daniel Snyder of SEMCOG and Reginald Beasley, William Cummings, and Jarka Vit of the Detroit Edison Company. Mary Ellen Oliver, of the University of Michigan Campus at Dearborn, was one of the teaching assistants.

To make it easy for trainees to obtain hands-on use of the RAS terminal, training sites included the Wayne County Community College campus on Greenfield Street (Western suburb of Detroit), the downtown Detroit Office of SEMCOG, and the northern suburb office of Detroit Edison. The time the terminal was located at each site depended upon the number of trainees and type of training at each location. In

addition to making the training available to practicing professionals in the region through the seminar, the community college also used the terminal to provide Landsat training for some students and staff in its Coastal Environmental Studies (CES) Project.

The CES program is funded by the National Science Foundation to develop a Certificate Program and an Associate Degree Program in Coastal-Environmental Studies in collaboration with the Engineering and Geography Department at Wayne State University, the Michigan Sea Grant Program, the Michigan Department of Natural Resources, the Geography Department at Eastern Michigan University and local coastal and environmental agencies. This two-year program trains students for careers as technicians, aides, and attendants in: 1) coastal research, 2) environmental studies, 3) chemical engineering, and 4) coastal planning. Landsat technology was readily integrated into the CES project through its geography, geology, and computer data processing courses. A list of available jobs for which students are being trained has been compiled by Dr. John Judd, Michigan Sea Grant Program, and Dr. Merle Raber, Michigan Department of Natural Resources. Representative sampling of potential employers in both private and public sectors has identified over 1,300 current positions for which these graduates will qualify.

SEMOG and Detroit Edison supported this seminar and used the terminals to train their own staff and to evaluate Landsat applications of interest to their respective organizations.

Detroit Edison used the terminal to train 12 staff members and to investigate the possibility of building a geographic data base for its 7600 square mile service region by integrating Landsat data with that digitized by its Interactive Graphic System (IGS). Immediate applications for this data include its use in models and analysis designed to aid the selection of transmission line corridors and power plant sites. During the training and demonstration period, a copy of



the RAS software was loaned to Detroit Edison for installation on their PDP-11/70.

In addition to providing facilities and staff to help seminar trainees, SEMCOG is using the terminal to investigate the use of Landsat as a possible source for updating the 1975 inventory of its seven-county planning region. The 1975 inventory was derived by interpreting and digitizing land use information from aerial photography. Anticipating the updating requirements, SEMCOG has collected new (1980) photography for the region. One method which SEMCOG is evaluating would use the Landsat data to point out possible areas of land use change and the aerial photographs to interpret these changes. The 1975 digital data base would then be edited to incorporate the changes to obtain the desired 1980 data base.

### 3.2 DEVELOP OPERATING METHODOLOGY

This objective was achieved through the assembly of equipment and techniques by which local users could obtain the capability to develop Landsat products and services through community colleges and small universities with the aid of a remote analysis station. Intermediate goals achieved in the development of this methodology included:

1. Assembly and test of three desk-top RAS computer terminals which can be connected to a central computing facility by telephone lines. The three remote stations comprised the key means to perform user training and to conduct technology demonstration projects.
2. Integrataion and test of the RAS, including modifications and development of new software where needed, to permit RAS operation at the sites of the participating colleges and public and private users.

The three (3) RAS terminals were completed and in continuous use for training and demonstrations from about mid-July, 1980.

The RAS terminal (Figure 3), reviewed in detail in Appendix B consists of a color CRT imagery display, with alphanumeric overwrite and keyboard, as well as a cursor controller and modem. This portable station can communicate via modem and dial-up telephone with a host computer at 1200 baud or hardwired to a host computer at 9600 baud. The station contains a Z80 microcomputer which controls the display refresh memory and remote station processing. Landsat data is displayed as three-band false-color imagery, one-band color sliced imagery, or color-coded processed imagery. Although the display memory operates at 256 x 256 picture elements, a display resolution of 128 x 128 can be selected to fill the display faster. The interactive operating techniques developed by ERIM permit most of the interaction to be performed at the lower resolutions and faster display fill rates, with high-resolution capability being used for viewing the final processed data.

The RAS features the following capabilities:

- o Low cost - the station can be assembled from readily available hardware for less than \$20,000.
- o System portability - the user supplies only electrical outlets and a telephone.
- o Interactive control via a simple, menu-driven language.
- o Dial-up access to host computer with selectable trade-off between image viewing speed and quality (resolution).
- o Histogram display, categorization accuracy tables, and results of category separation analysis.
- o Categorized image display in colors selected from list with over 40 options.
- o Generation of land cover tabulations directly from display by designating boundary of area with cursor.

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Figure 3. Remote Analysis Stations

- o Display of selected map categories over false color images.
- o Input of image and map control points for geometric correction.

The Remote Analysis Station is presently used to access the ERIM Earth Resources Data Center for Landsat data processing, including the generation of film images and thematic maps. The specifications for the host computer and peripherals are included in Appendix C.

### 3.3 DEVELOP AND IMPLEMENT TECHNOLOGY TRANSFER AND TRAINING AT THE GRASS ROOTS LEVEL

This objective required the development and delivery of a program of training and demonstrations designed to stimulate the market and encourage private users to become consumers and suppliers of Landsat products. Intermediate objectives achieved in the pursuit of the overall goal included:

1. Development of a training program containing workbooks, RAS User's Manual, and other material needed to instruct potential users in Landsat data processing and applications.
2. Training for staff of the colleges and organizations participating as terminal hosts, about 20 people.
3. Support in the form of RAS, host computer time, copies of training materials, and other materials needed to conduct the three cooperative technology transfer programs, which resulted in the training of another 80 or so people.

The first draft of the training program, which includes a set of five exercises which all trainees work through and a User's Manual, was completed during August, 1980. This program gives participants an opportunity to obtain training in the computer assisted interpretation of Landsat data and the generation of digital data bases from Landsat, aerial photography and map sources as well as to use these data bases for planning and management of the environment, natural resources, and

land use. All participants work through five exercises which involve 18 to 22 hours of training using the RAS terminals.

The following personnel were trained at ERIM, during the summer of 1980 in the use of the training material, so that they in turn could support the training and demonstrations at their respective organizations.

1. Dr. Eugene Jaworski, EMU	PI*
2. Steven Goodman, Daedalus Enterprises	AI**
3. Larry E. Reed, ERIM	AI
4. William Tyler, ERIM	AI
5. Roger Reinhold, ERIM	AI
6. George A. Leshkevish, NOAA	AI
7. Raj. A Aggarauala, U of M	AI
8. Carol Bronick, EMU	TA***
9. Iftekhar Bhatti, EMU	TA
10. Robert Karwowski, Michigan GSL Region	PI
11. Phillip Chase, Johnson and Anderson	AI
12. Vince Wilson, Mott Community College (MCC)	TA
13. Robert Fry, MCC	TA
14. Mark Hepe, MCC	TA
15. Dr. Elaine J. Wallace, Wayne County Community College	PI
16. Mary Ellen Oliver, U of M Dearborn	TA
17. Daniel Snyder, SEMCOG	AI
18. William T. Cummings, Detroit Edison	AI
19. Jarka Vit, Detroit Edison	AI
20. Reginald Beasley, Detroit Edison	AI

---

\*Principal Instructor  
 \*\*Associate Instructor  
 \*\*\*Teaching Instructor

21. Leslie Walter, EMU
22. Lu Anne Horvath, EMU

TA

Training material, RAS, and other support were also provided to the following organizations who delivered Landsat training and demonstration to over 80 trainees in their communities. The time periods for these efforts and a list of the host organizations providing facilities and staff to help trainees on the terminal

22 September to 4 October 1980

1. Dr. Eugene Jaworski, (313) 487-1480  
Geography and Geology Department  
Eastern Michigan University  
Ypsilanti, Michigan 48197
2. Steve Goodman (313) 769-5649  
Daedalus Enterprises  
Ann Arbor, Michigan 48106

15 October to 20 November 1980

1. Dr. Douglas E. Laine (313) 762-0278  
C.S. Mott Community College  
1401 East Court  
Flint, Michigan 48503
2. Robert Karwowski (313) 766-8593  
Michigan GLS Region  
Planning and Development Commission  
Flint, Michigan 48502

24 October to 19 December 1980

1. Dr. Elaine J. Wallace, Director (313) 584-9381  
Coastal Environmental Studies Project  
Wayne County Community College

8551 Greenfield  
Detroit, Michigan 48228

2. Daniel Snyder (313) 961-4266  
Southeast Michigan Council of Governments  
200 2nd Ave.  
Detroit, Michigan 48226
3. William T. Cummings (313) 649-7349  
Detroit Edison Company (Room 356 E.C.T.  
200 2nd Ave.  
Detroit, Michigan 48226

Limited by resources (e.g., two terminals), this method by which public and private organizations can join in cooperative efforts to share the terminals and other resources seems to be a good method of satisfying both training and demonstration requirements and in turn transferring Landsat technology to the largest number of professionals at the grass roots level.

#### 3.4 RECOMMENDED PHASE II PLAN

A 12-month program involving additional community colleges is recommended to continue the expansion of the use of Landsat technology at the local level. Emphasis in this program would be directed at achieving the following goals:

1. Continuing cooperative technology transfer programs to involve more colleges and local users with colleges providing self support of training courses with minimum NASA support.
2. Identifying alternative sources for the RAS terminals by encouraging suppliers to meet user needs on an investment basis and users to procure their own terminal once a successful demonstration project is completed.
3. Establishing new sources for the host computer service by

encouraging time-share companies, universities, and college computer-centers to adapt the RAS software

4. Upgrading the operational capability of RAS terminals and host software to simplify operations and add capability to manipulate other data sources when justified by user needs.
5. Upgrading training materials to facilitate their use by trainees and to incorporate additional exercises needed to introduce new terminal capabilities.

Work recommended to achieve these goals is reviewed in the following five sections.

#### 3.4.1 SUPPORT COOPERATIVE TECHNOLOGY TRANSFER PROGRAMS

Additional training and demonstration efforts are needed to continue to develop and illustrate the role of community colleges in partnership with the private and public sectors in the delivery of Landsat technology at the local level.

Most of the organizations participating in Phase I as a terminal host have requested an opportunity to provide continued host services for Phase II. Some of the participants are also taking actions to establish their own processing capability. Wayne County Community College and Wayne State University have requested funding from the National Science Foundation for RAS and software needed to establish and maintain training and demonstration programs in Wayne County. Wayne County Community College has also met with the Department of Education to discuss the Landsat program and seek funding. EMU and the Detroit Edison Company are also investigating ways of acquiring terminals and software to maintain a continuing role in the use of Landsat data. It is very possible that one or more of these Phase I participants will establish a Landsat data analysis capability within the next 12-month period if provided with continued encouragement and support by NASA.



The NASA activity in Southeast Michigan has caused other organizations to inquire about the possibility of participating in the Phase II program. It is not clear at this time how to best support programs which are more than several hundred miles from the host computer, due to the high cost of the telephone service between the terminal and its host. It is suggested that, in addition to continuing to support one or two Phase I participants, the Phase II effort include three additional colleges to organize cooperative technology transfer efforts in other regions of the state, (e.g., Southwest Michigan, the Lansing-State Capital area, and Central Michigan). These transfer activities would be modeled after the three Phase I programs where the college organizes and sponsors a seminar while several other local organizations also provide sites for the terminals where trainees can obtain additional hands-on training. An objective is to select a host for the terminal that will be convenient to the largest number of trainees (potential users).

Colleges who have expressed strong interest in organizing these new regions include:

State Capital Area: Lansing Community College

In the Lansing area, potential partners and trainees could also include staff from: Abrams Aerial Survey, John Snell Engrs., Michigan State University, Michigan Department of Natural Resources, Michigan Department of State Highways, other state agencies, the Tri-County Regional Planning Commission, and Resource Information Associates (RIA).

Lansing Community College has a PDP-11/35 computer, which is a potential near-term host for the RAS software. Other potential software hosts include the State of Michigan and MSU computers which are Burroughs 7700 and CDC 6500, respectively.

Central Michigan: Mid-Michigan Community College and/or Central Michigan University .

In the central Michigan area, additional transfer partners and trainees could also be drawn from Delta College University Center, Montcalm Community College, Environmental Sciences, Inc., Dow Chemical Company, and the Northeast and East Central Michigan Planning and Development Regions.

Central Michigan University uses a CDC Cyber 172 Computer which is also a potential host for the RAS software.

Western Michigan: Western Michigan University

Trainees or partners with Western could be drawn from Williams and Works (a major engineering firm in Grand Rapids), the five community colleges in the region, Southwest Michigan Regional Planning Commission, and Commonwealth Associates (a major utility company).

Western Michigan University has a strong interest in upgrading its remote sensing program to include training in Landsat data analysis. The expressed interest for the use of a RAS installation at Western includes the following:

1. A teaching tool in both regular classes and workshops, for community and small college faculties by the Geography Department.
2. A research tool in remote sensing mapping by the Geography Department.
3. A research tool to identify habitat types by faculty of the Biology Department.
4. Teaching the use of remote sensing in resource management to high school teachers and intermediate school district personnel as well as community service organization leaders by the Science and Mathematics Education Center.
5. A research and teaching tool for working with resource management problems for citizen groups and local government

by the University Center for Environmental Affairs under its National Science Foundation, Science for Citizens program.

6. A training and demonstration device for local government officials and private consultant firms working in resource management problems by the Southwest Michigan Planning Council (Substate Region III).

The Western Michigan University computer center contains a DEC PDP-10 computer. Preliminary investigations have confirmed the feasibility of adding the RAS software to this system. Addition of the software to this computer would also make the RAS operation available through the MERIT network which links computers at Western Michigan University, University of Michigan, Wayne State University, and Michigan State University.

A workshop is suggested for the first month of Phase II with NASA, ERIM, Phase I participants, and potential Phase II participants to assess the effectiveness of the Phase I training and demonstration efforts and to review recommendations and plans from the academic institutions who are proposing Phase II programs. The workshop will give Phase I and Phase II participants an opportunity to review program mistakes and successes, and give potential Phase II participants an opportunity to state their ideas on how to best conduct a cooperative technology transfer effort in their regions. In conjunction with NASA, academic institutions will be selected to organize and move forward with the Phase II transfer efforts. The Colleges will recruit organizations from the private and public sector to provide off-campus sites for the terminals and to supply trainees. NASA support to participants selected for Phase II would include training for Instructors and Associate Instructors, use of the RAS terminals, host computer service, and copies of the training materials.

### 3.4.2 ESTABLISH ALTERNATIVE SOURCES FOR RAS TERMINALS

Although the RAS terminals meet cost (under \$20K) and performance specifications, their excessive weight and size make the mobility needed for on-site training and demonstrations difficult. Ramtek, who supplied the current hardware, has been encouraged to develop more responsive configurations. Contacts have also been made with Tektronix, Science Applications Inc., Applied Dynamics, Log Etronics Inc., Innovative Digital Equipment (IDE) and other potential suppliers in hopes of establishing alternative terminal configurations that offer cost or performance advantages. IDE and Ramtek have provided cost for updated RAS configurations. Trainees will be encouraged to purchase their own terminals from one of the available sources upon the successful completion of demonstration or training. This activity would continue through Phase II.

### 3.4.3 DEVELOP ALTERNATIVE SOURCES FOR HOST COMPUTER SERVICES

As the distance between the terminal and the host increases, long distance telephone rates discourage terminal use. When the terminal can be hardwired to the host computer and operated at 9600 baud, it displays an image eight times faster than it does when operating through dial telephone line at 1200 baud.

These factors suggest that the plan for the orderly continued expansion of the use of Landsat technology must also address the needs of transferring the RAS software operations to other host computer facilities. The academic institutions and computer time-share firms would be encouraged to add software to their computers, where possible, so that local users could take advantage of faster display rates when the terminals are hardwired to the computer or lower telephone rates if dial-line operations are needed. Large universities, college centers, and time-sharing firms are already

, accustomed to servicing terminal users and could adapt the RAS software and terminals in stride.

Many of the large computer time-sharing firms are now supporting many clients, e.g., consulting engineering companies who are also potential users of Landsat technology. A well designed transfer of the RAS software to one or more of these hosts could have an immediate impact on the use of Landsat technology. Preliminary contacts have been made with a few organizations (e.g., Boeing Computer Services and National CSS, Inc.), in order to evaluate methods and possible benefits for accomplishing this transfer. A development of one or two alternative host computer services would be an important goal to achieve during Phase II.

#### 3.4.4 UPGRADING CAPABILITY OF RAS TERMINALS AND HOST SOFTWARE

From time to time, some software and firmware modifications will be needed in Phase II to make the terminals simpler to operate and to incorporate features which can be justified by user needs. Program evaluation forms completed by the trainees have already pointed out important changes that need to be made in the RAS firmware and software.

A more time-consuming and expensive effort to undertake in Phase II is the development of additional RAS software needed to manipulate land cover data derived from Landsat with that in other digital files, such as soils, topography, etc. This new development is needed in order to provide the trainees with a better appreciation of the usefulness of Landsat data.

To demonstrate the capability of merging and using Landsat data with other data sources, a number of alternative paths should be investigated - all paths require some firmware and/or software

modifications and/or additions. Methods recommended for investigation include:

1. Performing joint training and demonstration activities with organizations who are marketing geo data base equipment, software or services. Resource Information Associates, Inc. (RIA) for example, is a small, private sector firm marketing very low cost (under \$10K) microcomputer geographic information and mapping systems. These systems could be used to manipulate processed Landsat data (land cover) with soils, topography, etc., in models useful to engineering and public organizations doing township and county level planning. Models could include programs to locate prime agricultural land, estimate quantity and quality of stormwater run-off, assess wildlife habitat quality, etc. Funding for this activity would be needed to establish Landsat file(s) in floppy discs used by microcomputer(s) and perhaps support for work on models using Landsat data.
2. Performing a joint effort with Detroit Edison, who's interest is to establish Landsat processing capability in its PDP-11/70 computer, and to use this computer and associated digitizers and displays to establish and use a geo data base capability for its 7600 square mile service region. This approach may require assisting Edison with the work required to integrate RAS software onto its PDP-11/70, assisting in the development of software required to file and merge Landsat data with that derived by digitizing other data sources, assisting in the development of a model(s) which aids transmission line corridor selection, and the development of a county size demonstration project to demonstrate these new procedures.

3. Developing a telephone interface between the RAS terminal and the University of Michigan, Michigan State, or Wayne State computers so that trainees would have access to geo data base software available in these local computers. The U of M computer (MTS) contains the Harvard MGRID software, MSU provides Resource Analysis Procedure (RAP), and Wayne State provides the host services for SEMCOG. The SEMCOG files contain land use and other data for the seven-county planning region. SEMCOG is also a participant in the Phase I program and has continuing interest in Landsat technology.
4. Obtaining software from one of the NASA centers or from some other source and integrating it with RAS/ERDC programs. ERIM is currently investigating software available from NSTL/Earth Resources Laboratory. A program reported by Walter (1973 University of Florida) and referred to as the 'Optimum Land Allocation Computer Program' could be readily integrated into the RAS/ERDC software operations. This software could be used in a new exercise where the trainee generates and displays: 1) parameter images which show different resource parameters, e.g., land use soils, topography etc.; 2) maps which show the suitability of land for any one specified use based on suitability of categories; and 3) optimum user allocation maps showing the best use for land considering its suitability and priorities for various uses.
5. Transferring RAS software to a commercial time share company who has geo data software capability and who may already be supporting clients, e.g., engineering companies, who are also potential users of Landsat technology. For example, National CCS, a subsidiary of the Dunn & Bradstreet Corporation, provides a network of communications and computer services throughout the United States, England, and France. Programs

already in use on this host include ONSITE and MARKET BASE, two on-line demographic retrieval systems, ILUMS-Interactive land use mapping, AGS - a soil slope-stability analysis base management system. Boeing Computer Service provides UPGRADE - the User Prompted Graphic Data Evaluation System. At present, UPGRADE includes: air quality data (EPA SAROAD), water quality data (EPA STORET and USGS NASQAW) and demographic data (Census Bureau) which would be very useful to those involved in environmental programs. A well designed transfer of the RAS software to a host like CCS or Boeing could make a Landsat/Geo Data Base capability available to many potential Landsat users. To test this transfer method, support would be needed to install the software on the new host and to conduct demonstrations and market surveys.

Approximately 2 man-months of support are required to develop new software, data files, example products and other materials needed to demonstrate the usefulness of Landsat data when manipulated by models and programs with other data sources.

#### 3.4.5 UPDATE TRAINING MATERIAL

Training material, i.e., exercises and RAS User's Manual, as well as the RAS terminal itself, will evolve and change with use to incorporate new materials and features responsive to user needs. By the end of December approximately 100 trainees will have worked through the exercises and User's Manual. Almost all trainees to date have made some comments or corrections which will improve the training material. It is recommended that the training material be put on a word-processing machine during Phase II to facilitate revisions and additions. A Phase II objective would also be to make the training package completely 'self-contained' or as much so as possible. Ideally, a user with very little, or no background in remote sensing



supplied with a training package could train himself or herself to generate Landsat maps and data products with the use of the terminal.

Specific goals that should be achieved during Phase II include:

1. Rewrite RAS User's Manual: Rewrite, incorporating feedback from workshop participants and RAS trainees. Correct errors. Place on word processor.
2. Restructure the five RAS exercises: Utilizing feedback from RAS workshops and three cooperative technology transfer efforts, rewrite the existing five RAS exercises. Exercises should to be self-contained, and designed for someone with little professional training in remote sensing. Place on Word Processor.
3. Prepare at least three additional RAS exercises: Write several new exercises, including:
  - a. Manual interpretation of Landsat imagery.
  - b. Electronic service requests.
  - c. Integration of Landsat with data from other sources, e.g., aerial photographs, maps, other Landsat scenes, etc.
4. Prepare training package for Geo-data base applications: Prepare a set of exercises and update training manual for the generation and application of geo-data bases. Illustrate utility of LANDSAT data in this regard. Interface existing map data as well as aerial photographs. Emphasize digitizing, encoding, data storage, merging, retrieval, and data manipulation.
5. Generate video RAS training materials: Prepare color slides and other audio-visual materials needed to support training packages.

#### 3.4.6 SECOND NATIONAL TECHNOLOGY TRANSFER PROGRAM

The Second National Conference on the Role of Community Colleges in the National Technology Transfer Program is being planned for October 19-21, 1981. Location for the meeting will be Wayne County Community College Campus and the Ponchatrain Hotel downtown Detroit. Sponsors for the first national conference May 24, 1978 included: American Association of Community and Junior Colleges, Council of North Central Community Junior Colleges, Environmental Research Institute of Michigan, Michigan Community College Association, Southeastern Michigan League of Community Colleges, and the Southeastern Michigan Technical Assistance Program.

It is suggested that the NASA Phase II program cooperate with and assist in the organization and planning of this conference in order to obtain national awareness of NASA's efforts to transfer Landsat technology through community colleges. This conference should provide the exposure needed to initiate similar transfer efforts in other states.



## CONCLUSIONS

### 4.1 NETWORK AND PARTICIPANTS

To reach as many practicing professionals as possible within southeast Michigan, the Phase I participants were organized by region into three cooperative efforts for the purpose of delivering the training and demonstrations. The participants included: NASA, the sponsor, ERIM, who assembled and supplied the RAS and other materials, C.S. Mott Community College; Wayne County Community College; and Eastern Michigan University, who organized and sponsored seminars to attract practicing professionals to a program of training in Landsat technology and the off-campus host for the terminals where trainees obtained additional hands-on training. The off-campus host included: Daedalus Enterprises; Detroit Edison Company; Michigan GLS Region V Planning and Development Commission; and Southeast Michigan Council of Governments. An objective was to select a host that would be convenient to the largest number of trainees and who was also a potential user of the technology. The host also had the opportunity to use the terminals to conduct demonstration projects and to train other employees in their organization.

Approximately 100 people were provided hands-on training on the RAS terminals. Many others had the opportunity to attend brief demonstrations or one day workshops. Organizations providing staff for the hands-on training included:

- Daedalus Enterprises
- Detroit Edison
- Science Applications, Inc.
- NOAA
- Johnson and Anderson

Black & Veatch  
Neyer, Tiseo & Hindo, Ltd.  
Environmental Sciences, Inc.  
Department of Natural Resources - Puerto Rico  
SFERES - France  
Wayne County Community College  
C.S. Mott Community College  
Washtenaw County Community College  
GLS V Planning Region  
Southeast Michigan Council of Governments  
Eastern Michigan University  
Michigan State University  
University of Michigan  
Cranbrook Institute of Science  
General Motors Institute  
Tel Aviv University - Israel

Since the colleges sponsor the training programs through the usual registration-fee method (which pays the instructor) and the other terminal hosts are provided training facilities and staff support at no cost to NASA, the training and demonstration activities are almost self-supporting. NASA's support includes the use of the terminals with host computer support and copies of the training material. A program goal of having approximately 100 local participants trained in Landsat technology by 20 December 1980 was achieved. This concept for training and education utilizes existing organizations; one of its greatest strengths is that the various people and organizations occupy roles for which the required positioning and motivation have already been established.

#### 4.2 TRAINING MATERIALS

Three (3) RAS terminals, the RAS User's Handbook, and a set of five exercises were assembled and in continuous use since mid July

1980. The number of public and private organizations purchasing these materials for their own use provides one measure of gaging the effectiveness of NASA's technology transfer effort. A RAS terminal and associated software has been acquired and is in operation by the Institute for Applied Geosciences, Frankfurt, West Germany. A terminal has also been purchased by Texas Christian University (TCU). Other organizations likely to acquire terminals within the next month or two include: the U.S. Forest Service, NASA-Houston, The Society Francaise d'Etudes et de Recherches Economiques et Statistiques (SFERES)-Paris, France, and Telespazio-Rome, Italy. Wayne County Community College in conjunction with Wayne State University have requested funding from the National Science Foundation for RAS and software needed to establish and maintain training and demonstration programs in Wayne County. Wayne County Community College has also met with the Department of Education to discuss the Landsat program and to seek funding. Eastern Michigan University and the Detroit Edison Company are also investigating ways of acquiring terminals and software to maintain a continuing role in the use of Landsat data.

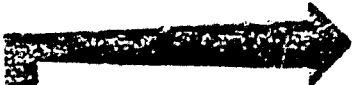
The investigation has demonstrated that recent developments in computer technology now make it possible for the private sector to provide high-quality Landsat products and services, using a desk-top computer terminal, at low initial investment of about \$20K. It also shows that community colleges as well as private and public organizations, which are readily available to the local user community, can join in cooperative efforts to deliver the needed training in the use of the terminals and the application of Landsat technology. In addition, this approach permits a gradual expansion of the initial low-cost user facility as confidence and available capital increase and as the system shows potential for easily merging other sources of data (soil, topography, etc.) into the Landsat analysis process.

#### 4.3 NEED FOR ADDITIONAL TECHNOLOGY TRANSFER EFFORTS

Additional training and demonstration efforts are needed to continue to develop and illustrate the role of community colleges in partnership with the private and public sectors in the delivery of Landsat technology at the local level. It is believed that this model extension network has been successfully demonstrated in Southeast Michigan and, if continued and expanded in Michigan and perhaps to a few other states, other colleges will follow nationwide. There are 1,240 community colleges and technical institutions in the United States, located in 426 of the 435 congressional districts (1977 data); each of these institutions has close connections with various public and private local organizations that could benefit from the use of Landsat or more directly, from the information it provides. The close relationship between the community colleges and the local communities makes the college ideal for transferring remote sensing technology. A technology extension network, with support to community colleges paralleling present-day vocational education funding, might be a legislative goal.

Appendix A  
Brochures from Colleges

Following are brochures which were published by the colleges to announce seminars conducted as part of the cooperative technology transfer efforts.



# ANNOUNCEMENT

## Special Course

### Eastern Michigan University



#### COOPERATIVE TECHNOLOGICAL TRANSFER

- . Daedalus Enterprises
- . Environmental Research Institute of Michigan
- . Michigan Community College Association
- . Washtenaw Community College
- . National Aeronautics and Space Administration
- . Southeastern Michigan Technical Assistance Program

GEO478 "SPECIAL TOPICS: REMOTE AREA SENSING"

#### Description

This special topics course has been designed as a training-demonstration and educational tool for potential users of LANDSAT (Satellite Imagery) technology. The course gives participants an opportunity to obtain training in the computer assisted interpretation of Landsat data, generation of digital data bases for planning and management of the environment, natural resources, and land use.

Participants will work through five exercises which will involve 18 to 22 hours of training using a color, interactive "Remote Analysis Station" (RAS). The RAS communicates with a central computing facility via telephone lines, and provides for generation of land cover maps and data products via remote command.

It is anticipated that some trainees may be selected to use the RAS terminal to undertake further work on a demonstration project of their choice.

#### Intended Audience/Prerequisites

The course is designed for practicing professionals and students who desire a comprehensive understanding at a basic level of the pertinent concepts, potentials, problems, and trade-offs associated with the practical and operational aspects of collecting, interpreting, and merging Landsat data with other data sources and applications for these data. No formal prerequisites are required. The course is open to undergraduate, graduate, and non-credit trainees. Additional work will be expected from the graduate students that enroll for this seminar.

#### Training Sites

A RAS terminal will be available at Daedalus Enterprises in Ann Arbor and at Eastern Michigan University (Room 222, Strong Hall) in Ypsilanti, Michigan. Dr. Eugene Jaworski of Eastern Michigan University will assign trainees to the site of their choice where possible.

#### Instructors

Principal Instructor: Dr. Eugene Jaworski, Assistant Professor, Eastern Michigan University, Geography & Geology Department, (313) 487-1480.

Associate Instructor: Steve Goodman, Daedalus Enterprises, (313) 769-5649.

Associate Instructors: Larry Reed, Bill Tyler, and Roger Reinhold, Environmental Research Institute of Michigan, (313) 994-1200.



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### Training Materials

This course uses the RAS terminal, workbooks, and other material developed by the National Aeronautics and Space Administration, which is evaluating methods of making Landsat satellite technology more readily available to the private and public sectors through local community colleges and universities. The course does not require additional texts or other materials.

### Credit

Two hours of undergraduate or graduate credit may be earned by completing this seminar. Enrollment on a non-credit basis is permitted. If you desire further information on non-credit, please contact Paul Borawski at (313) 487-0314.

### Cost

<u>Undergraduate</u>		<u>Graduate</u>		<u>Non-Credit</u>
Tuition	\$60.	Tuition	\$84.	\$60.
Registration Fee	\$20.	Registration Fee	\$20.	
Total	\$80.	Total	\$104.	

### Seminar Schedule

The following schedule will be adhered to. The course will run for two weeks commencing on September 22, 1980 and concluding on October 4, 1980. It will run five days a week from 8:00 a.m. until 10:00 p.m. Students will not be expected to attend the entire time; however, they will be expected to attend at least 30 hours of instructional time during this period. The course instructors will schedule students for computer time during the two week course.

### Class Size

The course is designed to accommodate up to twelve trainees with priority given to practicing professionals.

### Registration

A registration form has been attached; when completed, it should be mailed to the Registration Office, Briggs Hall, Eastern Michigan University, Ypsilanti, Michigan 48197.

### Similar Training Programs

Similar training programs will be offered in the October-November time period by Wayne and Charles Stewart Mott Community Colleges. These programs will deploy RAS terminals at sites in Wayne, Oakland, Genesee, and Ingham counties. For further information on these training opportunities contact: Dr. Douglas E. Lane, C.S. Mott Community College, 1401 East Court, Flint, Michigan 48503, (313) 762-0278, or Wayne Community College, Elaine Wallace, Coastal Environmental Studies, 8551 Greenfield, Detroit, Michigan 38228, (313) 584-9381.

# COMMUNITY SERVICES PROGRAMS

FROM  
DIVISION OF SCIENCE & MATH  
SATELLITE REMOTE SENSING

Physical Science 200-2 (May be taken for Credit or Audit)  
Section 7825F

Prerequisite: A Basic course in Geography or Geology, and two semesters of Algebra.  
(Practicing Professionals may disregard the prerequisites.)

Mott Community College will be offering a seminar on Satellite Remote Sensing during the Fall 1980 Semester.

The course has been designed as a training-demonstration and educational tool for potential users of the LANDSAT (Satellite Imagery) Technology. The course gives participants an opportunity to obtain training in the computer assisted interpretation of LANDSAT data, generation of digital data bases from LANDSAT, aerial photography and map sources; and to use these data bases for planning and management of the environment, natural resources, and land use.

Participants will work through five exercises which will involve 10 to 16 hours of training using a color, interactive "Remote Analysis Station" (RAS). The RAS communicates with a central computing facility via telephone lines, and provides for generation of land cover maps and data products via remote command.

THE DATE: October 15, 16, & 17, 1980 from 8:00 a.m. - 5:00 p.m.  
and an additional 8 hours by individual arrangement.

THE COST: Mott Community College District Resident \$55.00  
Michigan Resident outside MCC District \$67.00  
Out of State Resident \$91.00

## COOPERATIVE TECHNOLOGICAL TRANSFER

- |   |  |
|---|--|
| * Charles S. Mott Community College               | * Genesee-Lapeer-Shiawassee<br>Planning and Development Commission |
| * Environmental Research Institute<br>of Michigan | * National Aeronautics and Space<br>Administration                 |
| * Michigan Community College<br>Association       | * Southeastern Michigan Technical<br>Assistance Program            |

For additional information contact:

Douglas E. Laine, Chairperson Division of Science and Math  
313-762-0278

## SATELLITE REMOTE SENSING SEMINAR Section 7825F

To enroll, return the form below, along with your tuition check to: Off Campus Services Office, MCC, 1401 E. Court St., Flint, MI 48503. Sessions will be filled on a first come/first served basis. You will receive a seminar admission ticket, a campus map, and class room assignment by return mail.

Name: \_\_\_\_\_ Sex: ☐ Male Marital Status ☐ Single  
☐ Female ☐ Married  
Address: \_\_\_\_\_  
Phone: \_\_\_\_\_ Date of Birth: \_\_\_\_\_ School District in which you live: \_\_\_\_\_  
Social Security Number: \_\_\_\_\_  
I have attended MCC before ☐ yes ☐ no I am enrolling for: ☐ Audit  
If yes, last date attended MCC: \_\_\_\_\_ ☐ Credit

YOU ARE ENCOURAGED TO REGISTER EARLY. SPACE IN CLASS IS LIMITED.

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## ANNOUNCEMENT

SPECIAL COURSE

WAYNE COUNTY COMMUNITY COLLEGE  
COOPERATIVE TECHNOLOGICAL TRANSFER

# NASA

- SEMCOG (South East Michigan Council of Governments)
- Environmental Research Institute of Michigan
- Michigan Community College Association
- Detroit Edison
- National Aeronautics and Space Administration
- Southeastern Michigan Technical Assistance Program

### LANDSAT-REMOTE SENSING WORKSHOP

#### Description

This special topics course has been designed as a training-demonstration and educational tool for potential users of LANDSAT (Satellite Imagery) technology. The course gives participants an opportunity to obtain training in the computer assisted interpretation of Landsat data, generation of digital data bases for planning and management of the environment, natural resources, and land use.

Participants will work through five exercises which will involve 18 to 22 hours of training using a color, interactive "Remote Analysis Station" (RAS). The RAS communicates with a central computing facility via telephone lines, and provides for generation of land cover maps and data products via remote command.

It is anticipated that some trainees may be selected to use the RAS terminal to undertake further work on a demonstration project of their choice.

#### Intended Audience/Prerequisites

The course is designed for practicing professionals and students who desire a comprehensive understanding at a basic level of the pertinent concepts, potentials, problems, and trade-offs associated with the practical and operational aspects of collecting, interpreting, and merging Landsat data with other data sources and applications for these data. No formal prerequisites are required.

#### Training Sites

A RAS terminal will be available at:

Wayne County Community College, Northwest Region, 8551 Greenfield Road,  
Room A323 (October 24 - November 7 and December 8 - December 19)

SEMCOG -- Downtown Detroit (November 10 - November 21)

Detroit Edison, Troy, Michigan (November 24 - December 5)

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### Instructors

Principal Instructor: Dr. Elaine Wallace, CESP Director, Wayne County Community College, (313) 584-9381

Associate Instructors: Dan Synder, SEMCOG; William Cumming, Detroit Edison; Reginald Beasley, Detroit Edison; and Larry Reed, Bill Tyler, and Roger Reinhold, Environmental Research Institute of Michigan, (313) 994-1200 (ext. 576)

### Training Materials

This course uses the RAS terminal, workbooks, and other material developed by the National Aeronautics and Space Administration, which is evaluating methods of making Landsat satellite technology more readily available to the private and public sectors through local community colleges and universities. The course does not require additional texts or other materials.

### Cost

Registration Fee \$50

### Seminar Schedule

The following schedule will be adhered to. Participants will be expected to attend a two day workshop plus approximately 18 hours of terminal time.

Workshop -- October 24 9:00 a.m. - 4:00 p.m.  
October 27 9:00 a.m. - 4:00 p.m.

Room A200 Wayne County Community College -  
8551 Greenfield  
Detroit, Michigan 48228

### Class Size

The course is designed to accommodate up to twenty trainees with priority given to practicing professionals.

### Registration

You may register in advance, on a first-come first-serve basis, by calling Dr. Elaine Wallace, Wayne County Community College, 584-9381 (313)

Class size will be limited to twenty.



## Appendix B RAS OPERATING INSTRUCTIONS

### B.1 INTRODUCTION

#### B.1.1 THE RAS SYSTEM

The Remote Analysis Station (RAS) consists of a color CRT imagery display, with alphanumeric overwrite and keyboard, as well as a cursor controller and modem (Figure 1). This portable station can communicate via modem and dial-up telephone with a host computer at 1200 baud or hardwired to a host computer at 9600 baud. The station contains a Z80 microcomputer which controls the display refresh memory and remote station processing. Landsat data is displayed as three-band false-color imagery, one-band color-sliced imagery, or color-coded processed imagery. Although the display memory routinely operates at 256 x 256 picture elements, a display resolution of 128 x 128 can be selected to fill the display faster.

The slowest filling of the display would be for three-band false color imagery. False color display fill rates for the various resolution and baud rates are shown in the following table. The single band color sliced and categorized images (with less than 16 categories) will fill the display at twice the indicated false color rates.

#### APPROXIMATE FALSE COLOR DISPLAY FILL RATE AND RESOLUTION

<u>Baud Rate</u>	<u>Display Resolution-Pixels</u>	
	<u>128 x 128</u>	<u>256 x 256</u>
1200 (Dial Line)	120 sec.	8.5 min.
9600 (Local Line)	15 sec.	64 sec.



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The interactive operating techniques developed for RAS permit most of the interaction to be performed at lower resolutions and faster display fill rates, with the high resolution capability used for viewing the final processed data. The key to the relatively rapid fill rate is that the data being transmitted to the RAS by the host computer are already scaled to three bits per color, display resolution for the three CRT guns (red, green, and blue) prior to transmission with one bit, for graphics overwrite.

The RAS features the following capabilities:

- Low cost - the station can be assembled from readily available hardware for less than \$20,000.
- System portability - the user supplies only electrical outlets and telephone.
- Interactive control via a simple, menu-driven language.
- Dial-up access to host computer with selectable trade-off between image viewing speed and quality (resolution).
- Histogram display, categorization accuracy tables, and results of category separation analysis.
- Categorized image display in colors selected from list with over 40 options.
- Edit colors within areas enclosed via cursor - 'digital air brush'.
- Generation of land cover tabulations directly from display by designating boundary of area with cursor.
- Display of selected map categories over false color images.
- Input of image and map control points for geometric correction.
- Generate electronic service request for initial Landsat files, and subsequent image and data products.

### Integration of RAS with Host Computer

During this program the host computer for the RAS has been the PDP-11/70 computer in ERIM's Earth Resources Data Center (ERDC). Figure 2 illustrates the RAS - linked to its host via phone line and modem. The PDP-11/70 peripherals consist of the following:

- 1000K bytes of memory
- Four 176 megabyte disks.
- Two 2.5 megabyte program disks.
- Four 9-track computer tape transports.
- Two interactive display stations.
- One 16-channel terminal multiplexer.
- Two telephone modems.
- Datagrid digitizer table.
- Optronics drum film recorder.
- Two hardwired high-speed maximum likelihood processors.

#### B.1.2 RAS OPERATION

RAS features interactive control via a simple, menu-driven language. Table 1 lists the present 6-Option menu with sub-menus and the most frequently used off-line programs. After the user has logged in, operation is initiated by display of the six major options. To call one of the sub-menus, the user simply enters the appropriate letter, e.g., "R" for RADIOMETRIC and the corresponding options, false color, color slice, contrast etc., appear. Selection of one of these results in further options, e.g., band-color assignment, gain - offset levels, etc.

Each submenu pertains to a set of related options. The option QUIT is rather straight forward. RADIOMETRIC options are those which operate on the spectral or radiometric content of the data. In contrast, the GEOMETRIC options include functions



# REMOTE ANALYSIS STATION

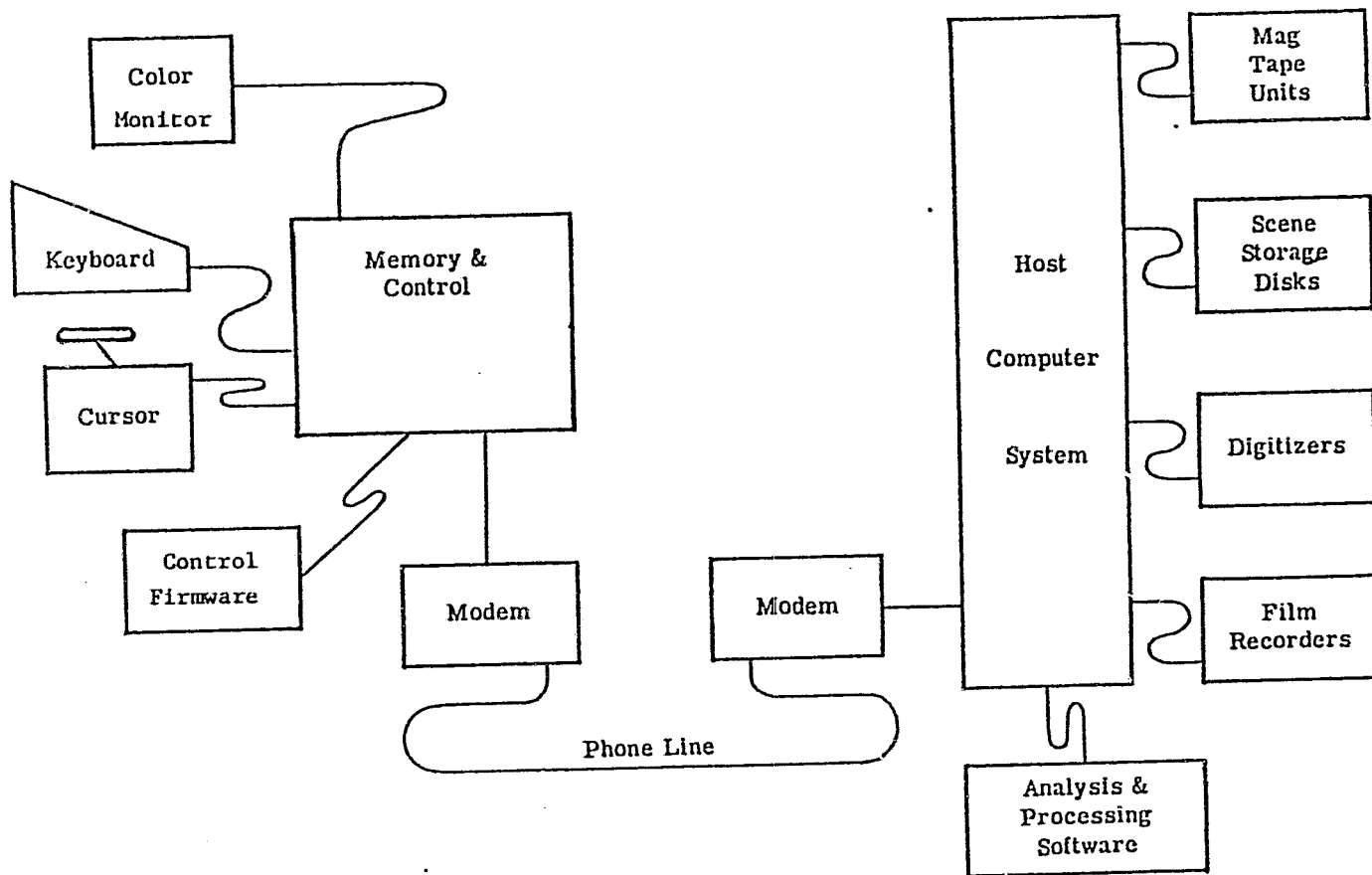


Figure 2. RAS and Host Computer

Table 1. RAS 6-Option Menu and frequently used off-line programs

1. QUIF` (Q)
2. RADIOMETRIC OPTIONS (R)
  - 1 FALSE COLOR
  - 2 COLOR SLICE
  - 3 CONTRAST
  - 4 CATEGORIZE
3. GEOMETRIC OPTIONS (G)
  - 1 LOCATION
  - 2 SCALE
  - 3 IMAGE CONTROL POINTS
4. TRAINING DATA (T)
  - ENTER TRAINING SET NUMBER?
  - ENTER UPPER LEFT CORNER
  - ENTER UPPER RIGHT CORNER
  - ENTER LOWER RIGHT CORNER
  - ENTER LOWER LEFT CORNER
  - NAME?
  - GROUP NUMBER & COLOR?
5. MULTISOURCE PROCESSING (M)
  - 1 CATEGORICAL DISPLAY
  - 2 CATEGORICAL OVERRIDE
  - 3 CO-OCCURRENCES
  - 4 EDIT
  - 5 AREA TABLES
6. UTILITIES (U)
  - 1 PAUSE
  - 2 STOP
7. FREQUENTLY USED OFF-LINE PROGRAMS
  - 1 TRAINING SET HISTOGRAMS (\$RHST)
  - 2 REMOTE CATEGORICAL ANALYSIS (\$RCA)
  - 3 ACCURACY TABLES (\$RCT)
  - 4 REMOTE CATEGORICAL PROCESSING (\$RCP)
  - 5 ELECTRONIC SERVICE REQUEST (\$ESR)
  - 6 TEXT EDITOR (EDI)

such as Location and Scale which are spatial or geometric in nature. Functions relating to training sets are contained within the TRAINING DATA menu. The MULTISOURCE PROCESSING submenu involves data from several sources as well as allows the user to manipulate and edit a previously categorized file. At present the UTILITIES option consists only of a Pause and Stop option. The PAUSE mode facilitates the temporary interruption of the RAS program for running off-line programs on an associated hard copy device, when available. Most of the performance statistics are run off-line so as not to unduly enlarge the basic RAS software.

#### B.1.3 SUMMARY OF OPERATIONAL STEPS

As indicated by the flow diagram, the RAS user may initiate a project at several different stages in the processing path (Figure 3). Many users will want to begin with a subscene which has been geometrically corrected, restored and resampled. Others who are more cost conscious may wish to process a raw Landsat subscene and perform a geometric correction after the creation of a categorized file. The following events describe those typically used by RAS operators to process Landsat data:

1. Data Collection. Prior to processing, the user acquires: LANDSAT Computer Compatible Tape (CCT), aerial photography, maps and other ground truth data needed to locate training areas for land cover categories; and, topographic maps needed for geometric corrections.
2. Specify study area and preliminary products. The user sends his Landsat tape to the host computer facility together with information needed to establish initial LANDSAT files of study areas. Information needed includes "mount" date, location of file in Landsat coordinates, and specifications for geometric corrections. If host is to input

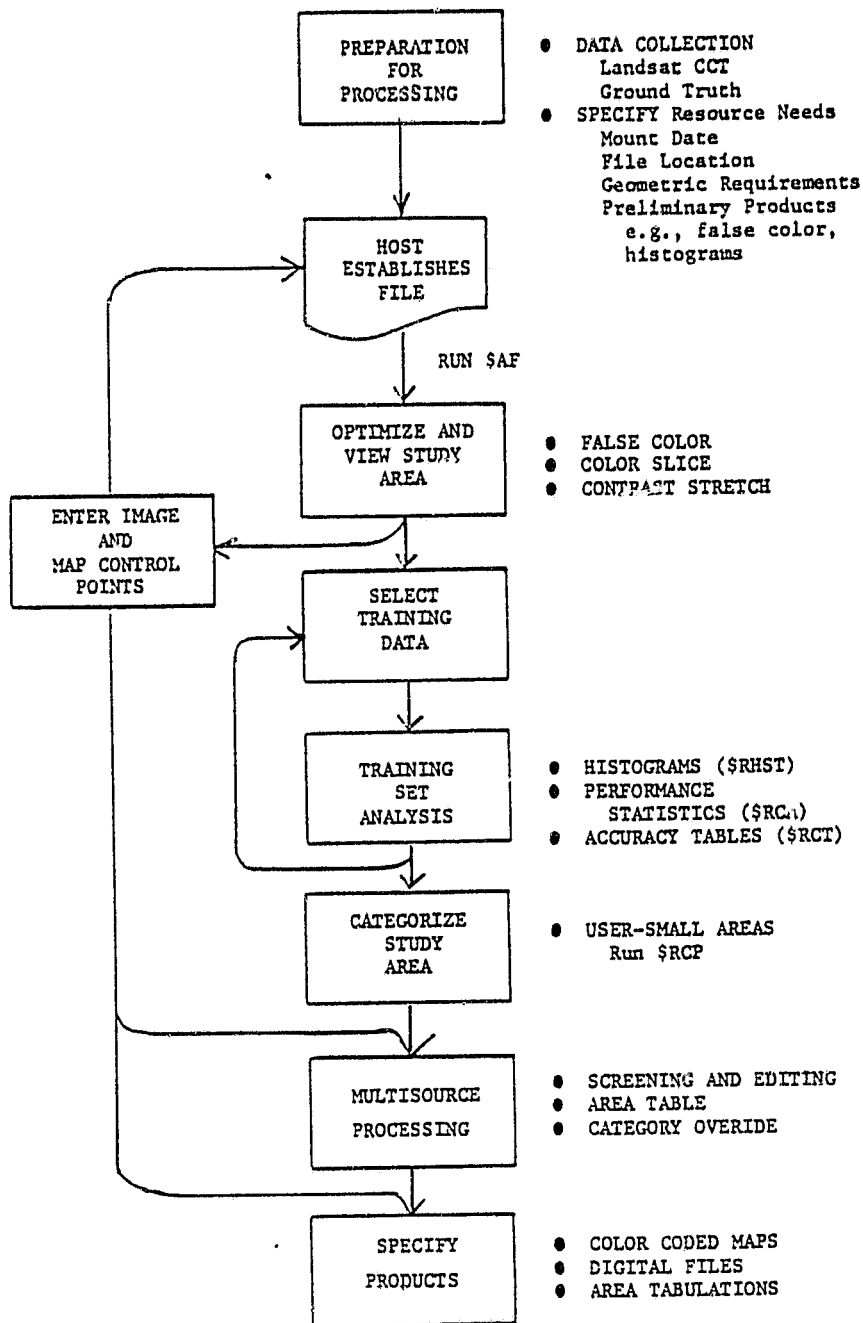


Figure 3. FLOWCHART ILLUSTRATING STEPS IN  
PROCESSING A SUBSCENE USING RAS  
TERMINAL

image and map control points for corrections, the user will also forward the topographic maps to the host facility. The user may also request histograms and a false color print of the study area at this time.

3. Establish link with files. At the specified mount date, the host computer reads the study area onto a disk and into the user's assigned file. The user should have at this time a RAS User's Manual, histograms, ground truth data (e.g., aerial photos and LANDSAT false color images) annotated with possible training site locations, and topographic maps, if ground control points are to be entered through the terminal. The user "dials up" the host computer. Two outside telephones have been established for this project.

4. Optimize and view study area and ground control point input option. Using selections from the Radiometric and Geometric submenus, the user will call up a display full of data from his disk area by scan line and pixel number. After general familiarization with the file, the user will optimize the false color and level sliced picture with the aid of the Histogram and Contrast display mode. If the data has not been corrected for geometric distortions, the user can elect to enter the image and map control points at this time or at any other time preceeding the generation of the final map and data products. Geometric considerations are reviewed further in a following section.

5. Select training data. Once map category needs have been established, and potential training set areas have been located on the display with the aid of ground truth data, the user begins to select training sets. More than one training set can be selected from the display without moving to another image location. Operating in the Training

Data mode, training sets are selected using a quadrilateral cursor, and the cursor coordinates along with training set identification and color codes are transmitted to the host computer.

6. Training set analysis. The user proceeds to interactive analysis after initial training sets are selected. This involves running the off-line Remote Categorical Analysis (RCA) program to establish processing coefficients (Walsh, 79, Wilson, 79) and selection of the Categorize option to display the processed data. Typically, the first analysis is performed after 6-8 training sets are selected. Categorized data on the display, together with statistical printouts (as overwrite) are reviewed, and then training sets refined and additional training sets selected until the desired results for up to 50 categories are available. Typically, 10 to 25 training sets for 6 to 15 map categories are selected. The categories are then aggregated down to the desired number of final map categories.

Statistics generated from off-line programs, such as RCA, ACCURACY TABLES (RCT), and TRAINING SET HISTOGRAMS (RHST), are viewed on display or on line printer. If the printer is not available, the display must be photographed if the information is to be retrieved before hard copy from the host computer arrives. When categorize is selected from the RADIOMETRIC submenu, the user views the interpreted data as it is being processed by the host computer with parameters computed by RCA from training data. Processing accuracy is often assessed by comparing this color-coded image with aerial photographs and other ground truth data. Some users photograph the display for more detailed analysis at a more convenient time. To minimize cost, many training and

demonstration projects end Landsat categorization activity at this point using the photographs and statistics to document the projects.

7. Apply analysis results to categorize study area.

Presuming the categorization is satisfactory, the user can categorize the entire file (study area) with Remote Categorical Processing (RCP), through the Electronic Service Request (ESR) program. Unless the files are relatively small (e.g., county or smaller) the categorization should be referred to the host which can process the files more efficiently with its hardwired high-speed processors.

8. Multisource processing. After the area of interest has been categorized and placed in the user's working area, some of the following multisources processing options can be selected as needed to manipulate and edit the processed data.

a. Categorical display. Categorical display can be requested to review the processed file. Since the interpreted file can be displayed much faster than files being processing, the user may select this mode to preview the file at a higher resolution than that accomplished during Land cover analysis. b. Editing.

Editing permits the user to change colors in any area enclosed with cursor. When this "digital airbrush" activity is accomplished by a careful operator with good ground truth, the effort can result in a significant improvement in classification accuracy. This option is also used to demonstrate how data from other sources (e.g., aerial photos, maps, etc.), can be integrated into Landsat files. c. Area tables. Area tables generated from

categorized data bounded by cursor on display lists acres, square kilometers, and percentage of area occupied by each land cover category. When boundaries of areas are complex or not visible on image, the host facility digitizes the boundary from maps supplied by the user and generates tabulations.

9. Specifying products. The user selects theme colors, and map products (scale and projection), digital files, area tabulation, etc. and transmits the order to the host computer via an Electronic Service Request. The products are generated off-line and sent to the user.

10. Geometric corrections. The user can contribute to geometric corrections if needed prior to or following training set analysis. In either case, the RAS user simply enters the image and map control points and receives an analysis of mapping error based on their use.

If corrections are needed, user specified options include: 1) when corrections are to be made; 2) whether RAS or host is providing image and map control points; 3) desired map projection and cell size; 4) mapping transformation or model (i.e., nearest neighbor, cubic convolution, restoration). Details of these options have been well documented (Wilson, 80). If corrections are performed before land cover analysis, the host establishes a corrected file in the users area. This file can be generated with virtually any map projection and cell size. A typical file would be in the UTM projection with 50 meter x 50 meter square cell. The cells would be east-west oriented with north imaged at the top of the display. This display facilitates comparison of Landsat image with available photographs and maps as well as location of potential training areas.



If geometric corrections are established with support from the terminal, the user first establishes uncorrected files. The image coordinate of map control points are located on the false color display and transmitted to the host computer when the Image Control Point option of the GEOMETRIC menu is executed with the cursor over the image control point. Latitude and longitude of corresponding points are derived from topographic maps and entered through the keyboard with off-line TEXT EDITOR (EDI) program. The Electronic Service Request (ESR) or other means can be used to inform the host of the selection of processing algorithms. Residual errors are transmitted to the user for review.

Appendix C  
SPECIFICATIONS FOR RAS HOST COMPUTER AND PERIPHERALS

C.1 REQUIREMENTS

C.1.1 GENERAL HARDWARE REQUIREMENTS

Following is a summary of equipment requirements and recommendations for supporting the RAS subsystem.

SUMMARY OF EQUIPMENT REQUIREMENTS AND RECOMMENDATIONS

Mainframe

- Floating point multiply/divide hardware\*.
- At least 16-bit addressing.
- Program memory.
  - Required 64K bytes.

Peripherals

- Random access disk memory: recommended minimum 5-megabyte (county size area).
- Magnetic tape drive: 9-track, 800 or 1600 bit per inch (BPI).
- RAS connected via RS-232 terminal port.

C.1.2 GENERAL SOFTWARE REQUIREMENTS

Certain machine software requirements are necessary to support the RAS subsystem without extensive modifications. A list of these requirements follows:

- The host machine must have a 16-bit or a 32-bit word size.
- The host machine must support FORTRAN IV or a higher FORTRAN language.
- The host machine must have machine language for disk and tape data handlers for image data.

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\* Recommended because of the high volume throughput required by imagery data processing.

## C.2 DESCRIPTION

### C.2.1 GENERAL

Essentially, RAS is a FORTRAN program used to support the processing and analysis of digital imagery data, such as remotely sensed data and ancillary data. The complete RAS software consists of the RAS program and numerous application modules.

The RAS program is coded in FORTRAN except for a few machine-dependent, FORTRAN-callable subroutines that are used to accomplish I/O, bit and byte manipulations, and certain control functions. Each of the application modules is also written in FORTRAN but relies on the operating subsystem for machine-dependent functions.

Appendix D  
RECOMMENDED READINGS

Brown, W.B., Remote Sensing Technology User Development Activities, Presented at the Hearings of the Subcommittee on Space Science and Applications, Committee on Science and Technology, United States House of Representatives, Washington, D.C., 1978.

Rogers, R.H., Landsat Technology Transfer Using Community Colleges, NASA Type II Reports: ERIM No. 147200-4-P, May 1980 and ERIM 147200-10-P, September 1980.

Rogers, R.H., C. Wilson, R. Dye, E. Jaworski, "Landsat Technology Transfer to the Private and Public Sectors Through Community Colleges and Other Locally Available Institutions," Proceedings of Fall Technical Meeting ACSM-ASP, Niagara Falls, NY, ASP Technical Paper, ISSN9271-4040, October 1980.

Rogers, R.H., Third Quarterly Report and Proposed Phase II Plan for Landsat Technology Transfer to the Private and Public Sectors Through Community Colleges and Other Locally Available Institutions, ERIM - 667414. December 1980.

Rogers, R.H., C. Wilson, R. Dye, E. Jaworski, 1981, "Landsat Technology Transfer to the Private and Public Sectors Through Community Colleges and Other Locally Available Institutions," Proceedings of the 1981 ASP-ACSM Annual Convention, Washington, D.C., February 1981.